Massachusetts Urban Forestry Program

The Citizen Forester

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As a child, I can remember watching "*Mutual of Omaha's Wild Kingdom"* on television and being utterly fascinated by aerial shots of the huge herds of animals that congregate on the Serengeti Plains in Africa or stream across the frozen tundra of the Arctic National Wildlife Refuge in Alaska. It seemed impossible that there could be that many wild creatures living together in one space. As the proliferation of wildlife and nature shows on today's television would seem to indicate, millions of other people are also moved by this same imagery.

And yet, how many of us are aware of the truly staggering congregations of organisms that exist quite literally under our very feet? For it is a fact that "A single gram of soil can contain more than a billion microorganisms." [1] Can you imagine what that would look like from the vantage of a Lilliputian aircraft skimming over the surface of the soil? Further, on the long list of things that we as humans take for granted in life, where does this extraordinary ecosystem upon we are all utterly dependent fall? For it is also a fact that "soil organisms break down organic residues, recycle nutrients, build soil structure, and degrade contaminants,"[2] all services that underpin our very existence.

The following article is from a wonderful introductory text to this remarkable world of tiny spaces, fierce, almost nightmarish predators and a beautifully balanced system of inter-relationships. I hope you find it as truly awe inspiring as I and that we all, as tree people, remember that seeing the forest for the trees also means looking down at the soil beneath our feet. – **Eric Seaborn, Program Coordinator**

The following article is taken from *Soil Biology Primer* [online]. Available: www.soils.usda.gov/sqi/concepts/soil_biology/biology.html

Chapter 1: THE SOIL FOOD WEB

By Elaine R. Ingham

SOIL BIOLOGY AND THE LANDSCAPE

An incredible diversity of organisms make up the soil food web. They range in size from the tiniest one-celled bacteria, algae, fungi, and protozoa, to the more complex nematodes and micro-arthropods, to the visible earthworms, insects, small vertebrates, and plants.

As these organisms eat, grow, and move through the soil, they make it possible to have clean water, clean air, healthy plants, and moderated water flow.

There are many ways that the soil food web is an integral part of landscape processes. Soil organisms decompose organic compounds, including manure, plant residue, and pesticides, preventing them from entering water and becoming pollutants. They sequester nitrogen and other nutrients that might otherwise enter groundwater, and they fix nitrogen from the atmosphere, making it available to plants. Many organisms enhance soil aggregation and porosity, thus increasing infiltration and reducing runoff. Soil organisms prey on crop pests and are food for above-ground animals.

THE FOOD WEB: ORGANISMS AND THEIR INTERACTION

The soil food web is the community of organisms living all or part of their lives in the soil. A food web diagram shows a series of conversions (represented by arrows) of energy and nutrients as one organism eats another (see food web diagram).

All food webs are fueled by the primary producers: the plants, lichens, moss, photosynthetic bacteria, and algae that use the sun's energy to fix carbon dioxide from the atmosphere. Most other soil organisms get energy and carbon by consuming the organic compounds found in plants, other organisms, and waste by-products. A few bacteria, called chemoautotrophs, get energy from nitrogen, sulfur, or iron compounds rather than carbon compounds or the sun.

As organisms decompose complex materials, or consume other organisms, nutrients are converted from one form to another, and are made available to plants and to other soil organisms. All plants – grass, trees, shrubs, agricultural crops – depend on the food web for their nutrition.

WHAT DO SOIL ORGANISMS DO?

Growing and reproducing are the primary activities of all living organisms. As individual plants and soil organisms work to survive, they depend on interactions with each other. By-products from growing roots and plant residue feed soil organisms. In turn, soil organisms support plant health as they decompose organic matter, cycle nutrients, enhance soil structure, and control the populations of soil organisms including crop pests. (See table of functions of soil organisms.)

ORGANIC MATTER FUELS THE FOOD WEB

Soil organic matter is the storehouse for the energy and nutrients used by plants and other organisms. Bacteria, fungi, and other soil dwellers transform and release nutrients from organic matter (see photo).

Organic matter is many different kinds of compounds – some more useful to organisms than others. In general, soil organic matter is made of roughly equal parts humus and active organic matter. Active organic matter is the portion available to soil organisms. Bacteria tend to use simpler organic compounds, such as root exudates or fresh plant

residue. Fungi tend to use more complex compounds, such as fibrous plant residues, wood and soil humus.

Intensive tillage triggers spurts of activity among bacteria and other organisms that consume organic matter (convert it to CO2), depleting the active fraction first. Practices that build soil organic matter (reduced tillage and regular additions of organic material) will raise the proportion of active organic matter long before increases in total organic matter can be measured. As soil organic matter levels rise, soil organisms play a role in its conversion to humus—a relatively stable form of carbon sequestered in soils for decades or even centuries.

FOOD SOURCES FOR SOIL ORGANISMS

"Soil organic matter" includes all the organic substances in or on the soil. Here are terms used to describe different types of organic matter.

Living organisms: Bacteria, fungi, nematodes, protozoa, earthworms, arthropods, and living roots.

Dead plant material; organic material; detritus; surface residue: All these terms refer to plant, animal, or other organic substances that have recently been added to the soil and have only begun to show signs of decay. Detritivores are organisms that feed on such material.

Active fraction organic matter: Organic compounds that can be used as food by microorganisms. The active fraction changes more quickly than total organic matter in response to management changes.

Labile organic matter: Organic matter that is easily decomposed.

Root exudates: Soluble sugars, amino acids and other compounds secreted by roots.

Particulate organic matter (POM) or Light fraction (LF) organic matter: POM and LF have precise size and weight definitions. They are thought to represent the active fraction of organic matter which is more difficult to define. Because POM or LF is larger and lighter than other types of soil organic matter, they can be separated from soil by size (using a sieve) or by weight (using a centrifuge).

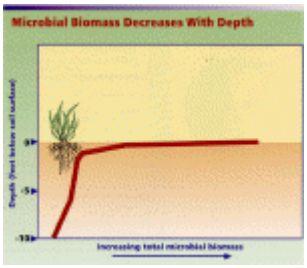
Lignin: A hard-to-degrade compound that is part of the fibers of older plants. Fungi can use the carbon ring structures in lignin as food.

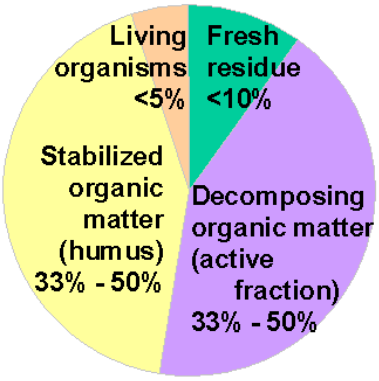
Recalcitrant organic matter: Organic matter such as humus or lignin-containing material that few soil organisms can decompose.

Humus or humified organic matter: Complex organic compounds that remain after many organisms have used and transformed the original material. Humus is not readily decomposed because it is either physically protected inside of aggregates or chemically

too complex to be used by most organisms. Humus is important in binding tiny soil aggregates, and improves water and nutrient holding capacity.

Components of Soil Organic Matter





WHERE DO SOIL ORGANISMS LIVE?

The organisms of the food web are not uniformly distributed through the soil. Each species and group exists where they can find appropriate space, nutrients, and moisture. They occur wherever organic matter occurs – mostly in the top few inches of soil (see figure), although microbes have been found as deep as 10 miles (16 km) in oil wells.

Soil organisms are concentrated:

Around roots. The rhizosphere is the narrow region of soil directly around roots (see photo). It is teeming with bacteria that feed on sloughed-off plant cells and the proteins and sugars released by roots. The protozoa and nematodes that graze on bacteria are also concentrated near roots. Thus, much of the nutrient cycling and disease suppression needed by plants occurs immediately adjacent to roots.

In litter. Fungi are common decomposers of plant litter because litter has large amounts of complex, hard-to-decompose carbon. Fungal hyphae (fine filaments) can “pipe” nitrogen from the underlying soil to the litter layer. Bacteria cannot transport nitrogen over distances, giving fungi an advantage in litter decomposition, particularly when litter is not mixed into the soil profile. However, bacteria are abundant in the green litter of younger plants which is higher in nitrogen and simpler carbon compounds than the litter of older plants. Bacteria and fungi are able to access a larger surface area of plant residue after shredder organisms such as earthworms, leaf-eating insects, millipedes, and other arthropods break up the litter into smaller chunks.

On humus. Fungi are common here. Much organic matter in the soil has already been decomposed many times by bacteria and fungi, and/or passed through the guts of earthworms or arthropods. The resulting humic compounds are complex and have little available nitrogen. Only fungi make some of the enzymes needed to degrade the complex compounds in humus.

On the surface of soil aggregates. Biological activity, in particular that of aerobic bacteria and fungi, is greater near the surfaces of soil aggregates than within aggregates. Within large aggregates, processes that do not require oxygen, such as denitrification, can occur. Many aggregates are actually the fecal pellets of earthworms and other invertebrates.

In spaces between soil aggregates. Those arthropods and nematodes that cannot burrow through soil move in the pores between soil aggregates. Organisms that are sensitive to desiccation, such as protozoa and many nematodes, live in water-filled pores. (See Figure page 1.)

WHEN ARE THEY ACTIVE?

The activity of soil organisms follows seasonal patterns, as well as daily patterns. In temperate systems, the greatest activity occurs in late spring when temperature and moisture conditions are optimal for growth (see graph). However, certain species are most active in the winter, others during dry periods, and still others in flooded conditions.

Not all organisms are active at a particular time. Even during periods of high activity, only a fraction of the organisms are busily eating, respiring, and altering their environment. The remaining portion are barely active or even dormant.

Many different organisms are active at different times, and interact with one another, with plants, and with the soil. The combined result is a number of beneficial functions including nutrient cycling, moderated water flow, and pest control.

THE IMPORTANCE OF THE SOIL FOOD WEB

The living component of soil, the food web, is complex and has different compositions in different ecosystems. Management of croplands, rangelands, forestlands, and gardens benefits from and affects the food web. The next unit of the Soil Biology Primer, “The Food Web & Soil Health,” introduces the relationship of soil biology to agricultural productivity, biodiversity, carbon sequestration and to air and water quality. The remaining six units of the Soil Biology Primer describe the major groups of soil organisms: bacteria, fungi, protozoa, nematodes, arthropods, and earthworms. For more information about the diversity within each organism group, see the list of readings at the end of “The Food Web & Soil Health” unit.

Footnotes:

1. Washington State University Web site at
http://www.puyallup.wsu.edu/soilmgmt/SoilBiology.htm

2. Washington State University Web site at
http://www.puyallup.wsu.edu/soilmgmt/SoilBiology.htm

Picks and Shovels

For more related information

Washington State University Web site at
http://www.puyallup.wsu.edu/soilmgmt/SoilBiology.htm

Soil Biology Primer [online]. Available:
http://soils.usda.gov/sqi/concepts/soil_biology/biology.html

NRCS Soil Biology Technical Notes at
http://soils.usda.gov/sqi/concepts/soil_biology/biology.html

Brady, Nyle C.; Weil, Ray R.; Elements of the Nature and Property of Soils , second edition, Pearson, Prentice Hall, 2004

Lowenfels, Jeff; Lewis, Wayne; Teaming With Microbes: A Gardeners Guide to the Soil Food Web, Timber Press, 2006

Growing Greener

Town of Mendon with assistance from a "DCR U&CF National Grid Challenge Grant" (go to: http://www.mass.gov/dcr/stewardship/forestry/urban/urbanGrants.htm) the town will be hiring a consulting arborist to develop a storm mitigation plan. The plan will outline where to stock pile debris, assemble crews and contractors in the event of a storm emergency, prepare maps of priority routes and compile emergency contact information for town officials and employees. It will also include the use of the Storm Damage Assessment Protocol which is part of the "iTree" (go to: http://www.itreetools.org/) suite of tools.

Growing on Trees

Massachusetts Tree Warden's & Foresters Association announces the recipient of the George E. Stone Award. Named after it's founder the award honors an individual or organization for contributions in public tree care or advocacy. Sturbridge tree warden Thomas A. Chamberland received the award in January at the MTW&F 95th annual meeting. **Congratulations Tom – much deserved!**

National Arbor Day Announces the Theme for the 2008 Poster Contest "Trees are Terrific… Inside and Out!" Over 75,000 fifth grade classrooms and home schools across

America participated in the 2007 Arbor Day National Poster Contest sponsored by Toyota. To receive free lesson plans that correlate with National Science and Art visit the NADF website: www.arborday.org/kids/postercontest/index.cfm . For information about the Massachusetts contest, please contact Eric Seaborn at eric.seaborn@state.ma.us or 617-626-1468.

New England Chapter of the International Society of Arboriculture 2008 Arbor Day Scholarship A fund was created to support local towns and cities of need to support an Arbor Day Event. The Arbor Day Event should be designed to increase the awareness of the general public of the profession of arboriculture and of the importance of planting and maintaining healthy trees residing within our communities. In 2008, up to two awards of $250.00 will be awarded. Deadline for receipt of applications is February 22, 2008. Applicant must be a current member of the New England Chapter of the ISA. For a complete application and more information, please go to: http://www.newenglandisa.org/2008_Revised_NECISA_ScholarshipApplication.pdf

On The Horizon

New England Grows at the Boston Convention & Exhibition Center, Boston MA. February 6–8, 2008 New England's premier trade show for the Green Industry with classes, lectures and vendors available to discuss the latest in the Industry. For more information visit: www.NEGrows.org or 508-653-3009

The 4th Hemlock Woolly Adelgid Symposium at the Hartford Hilton, Hartford, CT February 12-14 2008. Hear about the latest research on biological and chemical controls for HWA as well as best management practices for the conservation of Hemlock and the historical and future impacts of exotic insects. For registration information visit the USFS North East Area web page http://na.fs.fed.us/fhp/hwa or contact Katherine McManus at kmcmanus@fs.fed.us or 203-230-4330

Strategies and Products for Managing Weeds and Invasive Plants in the Landscape at the Public House, Sturbridge, MA February 27, 2008 this program will give an overview of the many strategies and products available for managing weeds and invasive plants in ornamental beds and landscape. For complete list of workshops and registration information visit www.umassgreeninfo.org or contact UMass Extension at 413-545-0895

Electrical Hazards Awareness Program at UMass Amherst, March 1, 2008.
The EHAP workshop is sponsored by the Tree Care Industry Association (TCIA), in cooperation with UMass Extension. For more about the workshop and registration information visit www.tcia.org and click the Safety tab, then EHAP. *A nominal fee of $12 will be charged for lunch and refreshments.

2008 National Conference on Urban Ecosystems Nature and the Network: Building a new framework for people and nature to work together May 28 - 30, 2008
Caribe Royal Hotel Orlando, Florida. Organized by American Forests, the Conference will bring together members of the business, government and conservation communities, to solidify and expand partnerships, assess our progress and plan strategies for building communities of the future. www.americanforests.org/conference

Religious Organizations and the Earth's Environment
Over the past few years, involvement of religious organizations in the earth's environmental stewardship movement has gathered momentum, with rallying contributions from political, music, film, and journalistic personalities. Marty Ostrow and Terry Kay Rockefeller's documentary ***Renewal*** is the first feature-length documentary to bring to light the contributions being made by America's religious institutions, and the **MassReLeaf Ministry** http://www.macucc.org/emj/httpwww.macucc.orgemjreleaf2.htm supports the showing of this film. This compelling film explores 8 diverse faith-based initiatives that exemplify the range and vitality of America's religious-environmental movement, from Evangelical Christians protesting mountaintop removal coal mining in Kentucky to Buddhists working to save trees through paper conservation. National groups such as Interfaith Power and Light as well as local organizers such as New Jersey's GreenFaith coalition are highlighted. ***Renewal*** **will be shown at the Boston Museum of Fine Arts from February 21 through March 2.**
Tickets: Members, seniors and students $8; general admission $9. Discount matinee prices (weekday until 5 pm; weekends until 12:30 pm) are $6, $7. To purchase please call the box office at 617-369-3687 or online at www.mfa.org/film.

Renewal
Thu, Feb 21, 7:45 pm
Sat, Feb 23, 1:45 pm
Sun, Feb 24, 3:50 pm
Fri, Feb 29, 6 pm
Sat, Mar 1, 2 pm
Sun, Mar 2, 3:45 pm
Renewal by Marty Ostrow and Terry Kay Rockefeller (2008, 90 min)

Species Spotlight

Cotinus obovatus
American Smoke Tree

Hardiness Zone 4

Edible Tree Fruit: No

General Description: Native to Southeastern United State this deciduous small tree or large shrub has a medium growth rare and can grow 20'- 30' tall. The medium texture crown has an upright oval habit that when grown in the open can have a width equal to its height. The Obovate shaped leaves are alternate and simple 2" to 5" long and half as wide with an entire leaf margin. Leaf color is bluish green in summer turning a showy yellow, orange, red to purple in the fall. Greenish white panicle flowers 6" to 10" in length bloom in early spring producing small fruit of little ornamental importance. The bark forms a tight flaky pattern and is an attractive gray-brown.

Culture: Performs best in full sun and is very tolerant of hot, dry, gravelly soils yet is adaptable to many soils and pH ranges. Easily transplanted and establishes quickly with minimal transplant shock.

Landscape Use's good for sites with poor soils or as a specimen tree, small groupings or shrub borders to accent mid to late summer flowers and showy winter bark.

Liabilities: Susceptible to verticillium wilt otherwise few serious pest problems.

Cultivars/Varieties: None

For more information on this and other tree species, see
www.hort.uconn.edu/plants/c/cotobo/cotobo1.html

The Citizen Forester is made possible through a grant from the USDA Forest Service Urban and Community Forestry Program and the Massachusetts Department of Conservation and Recreation, Bureau of Forestry.

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If you have questions about Urban and Community Forestry, contact:

Eric Seaborn, Coordinator eric.seaborn@state.ma.us

Alan Snow Community Forester, Central & Western Mass
alan.snow@state.ma.us

Bureau of Forestry
Department of Conservation and Recreation
251 Causeway Street, Suite 900
Boston, MA 02114

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